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THE

AMERICAN NATURALIST

VOL. XXIX. November, 1895. 347

THE DISTINCTION BETWEEN ANIMALS AND PLANTS.

BY J. C. ARTHUR.[1]

The animal kingdom and the vegetable kingdom were not sharply distinguished in the days when science was young, some two or three centuries ago, when even learned men believed in the Scythian lamb,[2] that grew on the top of a small tree-trunk in place of foliage, and in the wonderful tree of the British Isles,[3] whose fruit turned to birds when it fell on the ground, and to fishes when it fell into water; and the two kingdoms are not sharply distinguished to-day, when learned men do not agree upon the systematic position of the Myxogastres and other low forms, some going so far as to assert that many of the simple organisms are on neutral ground, belonging no more to one than to the other kingdom. Dr. Asa Gray[4] once said that "no absolute distinction whatever is now known between them. It is quite possible that the same organism may be both vegetable and animal, or may be first the one and then the other."

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[1] Read before joint session of Sections F and G of the A. A. A. S., Springfield meeting, Sept. 2, 1895.

[2] Duret, Histoire admirable des plantes, 1605; Jonston, Dendrographias sive historiæ naturalis de arboribus, 1662; LaCroix, Connubia florum, ed. 2, 1791.

[3] Duret, l. c.; Gerarde, Herball, 1597.

[4] Atlantic Monthly, 1860; Darwiniana, p. 124.

So numerous have been the vain attempts to find some character of universal diagnostic value that it seems rash indeed to make another trial. But, in case of failure, no harm will be done, even if no advance has been made.

In all attempts, so far as they have come to my notice, the characters selected to distinguish the two kingdoms have been physiological, and not structural. Yet, in the classification of plants among themselves, or of animals among themselves, the characters of acknowledged value are drawn from structure, and physiological distinctions are only considered when the organisms are very minute or simple, like the bacteria and yeasts, or for some other exceptional reason. It seems, therefore, highly illogical to accept a purely physiological character as fundamental for separating the two kingdoms.

On this ground we would discard Linnæus' classification:[5] Lapides crescunt, vegetabilia crescunt et vivunt, animalia crescunt, vivunt et sentient; and that of Hæckel[6] who accords the chlorophyll function to plants and not to animals; and that of Sedgwick and Wilson[7] who find the sole characteristic of animals to be dependence upon proteid food; and also that of Dangeard[8] and Minot,[9] who distinguish the two kingdoms by the manner in which the food, or food material, is taken into the organism. There are also characters, for which I need cite no authority, that were advocated at different times in the past, which have since been discarded for lack of universality, such as a carbon dioxide respiration in plants and an oxygen respiration in animals, that plants exclusively convert inorganic matter into organic matter, that plants alone produce chlorophyll, or cellulose, or starch, etc.

[5] Philosophia botanica, ed. 4, 1809, p 1.

[6] Systematische Phylogenie der Protisten und Pflanzen, 1894; abs. in Science, i, 1895, p 272.

[7] Biology, 1886, p. 167.

[8] Ann. des sci. nat., 7th ser., Bot. T. V.; Comp. rend., 1887; Le Botaniste, 1895, p. 188.

[9] Science, i, 1895, p. 311.

In attempting to distinguish animals and plants by means of definite characters, there is another point that needs attention. Primary characters are to be drawn from the mature condition of the organism, and not from the reproductive or the immature state. This is such an obvious proposition in the ordinary classification of animals or plants, that it seems strange that in diagnosing the two kingdoms it should have been entirely overlooked. There are remarkable similarities in methods of reproduction among plants and animals, not only in the processes, but in the external means for protection and in the methods of dissemination of the reproductive bodies. Especially is this true of non-sexual reproduction among the lower orders. The reproductive structures are sometimes very elaborate, and the organism in that state often attracts more attention than in the vegetative condition, as in the case of the Myxogastres. It is obvious that the individual is the object that we are studying and classifying, and therefore the most fundamental of characters should apply to the individual—the vegetative organism, and not to the mode by which a succession of individuals is maintained.

The following definition of plants and animals is suggested as meeting the requirements of the conditions of classification mentioned above:

PLANTS are organisms possessing (in their vegetative state) a cellulose investment.

ANIMALS are organisms possessing (in their vegetative state) a proteid investment, either potential or actual.

The organism may be a cellular body with the investment extending to each protoplasmic unit, as is usual in plants, or it may be a cœnocytic body with the investment extending only to the compound units, as in most animals and in some plants (*e. g., Mucorinæ, Siphonaceæ*). As a rule, the investment is most prominently developed upon the general outer surface of the organism.

By designating the constitution of the walls, it is intended to cover only the original or basic substance of which they are composed, and has no reference to subsequent depositions or infiltrations, of whatever character they may be. Thus in the walls of grasses and Equiseti there is often a great amount of silica, in certain seaweeds (*Corallina*) much lime, in tunicates so much cellulose that it sometimes amounts to one-fourth of the dry weight,[10] and yet, in the case of the plants named, the original and fundamental substance of the wall is cellulose, and in the animals proteid. A small amount of nitrogen has recently been found by Winterstein[11] associated with the cellulose of fungi, but in what form has not yet been determined. Other instances of a similar nature might be cited.

It may be well to say that by cellulose is meant both primary and compound celluloses and their various modifications, all of which are carbohydrates, and by proteïd is meant the nitrogenous, non-protoplasmic substance of walls, no formula for which is known, but which Cross and Bevan[12] suggest "may prove to be of similar carbon configuration to that of cellulose."

There are some organisms which, in their vegetative state, consist of so-called naked protoplasm, of which the most conspicuous and well-known examples are the Myxogastres. Many species of these fungus-animals (Pilzthiere), however, are known to possess a distinct proteid envelop about the plasmodium[13] which, by its chemical reaction, is shown to be non-protoplasmic, and it may be inferred that careful examination will find it present in most of the species, and that it can be considered as potential or undeveloped in the others. They are, therefore, distinctly animal in their fundamental characteristic. Although usually treated in botanical text-books and studied by botanists, they were long since shown by DeBary[14] to have more points of agreement with animals than with plants, and he believed them to be "outside the limits of the vegetable kingdom." This separation by DeBary was made without any reference to a proteid membrane, which may, however, be considered the crucial diagnostic character.

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[10] Schmidt, Zur vergleichenden Physiologie der wirbellosen Thiere. Ann. d. Chem., liv, 1845, p. 318; Schacht, Müller's Archiv, 1851, p. 185; Schäfer, Ueber Thiercellulose, Ann. d. Chem., clx, 1871, p. 312.

[11] Ber. d. d. chem. Ges., xxviii, (1895) p. 167.

[12] Cellulose, 1895, p. 88.

[13] DeBary, Morphology and biology of the fungi, mycetozoa and bacteria, p. 426.

[14] Die Mycetozoen, ed. 2, Leipzig, 1864; l. c., p. 444.

Another set of organisms, with apparently naked protoplasm during the vegetative stage, are the endophytic parasites belonging to the group of genera represented by Synchytrium, Woronina, Olpidiopsis, Rozella and Reesia. Whether they ever possess any demonstrable proteid envelop has not been ascertained, but it is known that they have no cellulose envelop; they are, therefore, not plants, and must, in consequence, be animals. This disposition of them has already been made by Zopf[15] on the ground that a " plasmodial character of the vegetative condition is entirely foreign to the Eumycetes." The Chytridiaceæ, which are usually associated with the Synchytria, have a much reduced but demonstrable mycelium formed of cellulose, and are, therefore, unmistakable plants.

Among the lowest forms, as generally classified, the Rhizopods, including Amoeba, and the far simpler Monera, show no distinct proteid envelop, but neither do they show any indication of a cellulose envelop, and as the other affinities appear to be with animals rather than with plants, they are doubtless rightly placed in the animal kingdom. It is reasonable to expect that more careful examination will, in some cases, show a simple or imperfectly formed proteid envelop.

It may be well to specifically state for sake of clearness that the nature of the investment of spores or sporophores has no significance in this connection. They are to be regarded as adaptations without primary classificatory value.

The crucial diagnostic character, which is here proposed, has in its favor the separation of plants and animals upon a line which accords well with the consensus of opinion of thoughtful students, both botanists and zoologists, an opinion which has been formed from a variety of structural, physiological and developmental data. True relationship must necessarily be adduced from a study of the full life-history of organisms, diagnostic characters only forming points of departure.

[15] Die Pilze, 1890, p. 2.